

OPENINGS REMARKS

The Examiner Kripa Sagar is thanked for carefully examining and reviewing the subject patent application. The specifications and claims have been reviewed in accordance with all the Examiner's kind suggestions, and after amending the specifications and all the claims 1-30 in accordance with the Examiner's helpful suggestions, all claims are now believed to be in condition for allowance.

The Examiner is acknowledged for finding the amended claims, in the amendment filed on 6/4/02, Paper No. 5, sufficient to overcome the prior rejections under U.S.C. 112.

SUMMARY OF THE APPLICANT'S INVENTION

Key to the Applicant's invention is the subsequent use of two layers of different positive photoresists, possessing different exposure wavelength sensitivities. It is a general object of the present invention to provide a new and improved method of forming semiconductor integrated circuit devices, and more specifically, in the formation of self-aligned dual damascene interconnects and vias, which incorporates two positive photoresist systems, which have different wavelength sensitivities, to form trench and via openings with only a two-step etching process. In addition, the two layers of

photoresist exhibit different etch resistant properties, for subsequent selective reactive ion etching steps. The use of a "high contrast" positive photoresist system has been developed wherein the resist system exposure sensitivity is optimized for wavelengths, deep-UV (248nm) for the top layer of resist, the trench pattern, and I-line (365nm) for the bottom layer of resist, the via pattern. The resist system provides a process in dual damascene for trench/via formation and has the following properties: selective etch resistance, thermal stability during processing, ease of processing and developing, and good adhesion properties.

CLAIM REJECTIONS - 35 U.S.C. 103(a)

ARGUMENTS:

The Examiner made reference to another related prior art background patent, found in the Applicant's specifications, namely, U.S. Pat. No. 5,877,076 entitled "Opposed Two-Layered Photoresist Process for Dual Damascene Patterning" granted Mar. 2, 1999 to Dai. As the Examiner states, there are numerous process variations available in forming a stepped profile in a resist stack. However, Dai teaches a dual damascene photo process using two photoresist layers with opposite types of photoresist, one positive and one negative.

The Dai scheme requires a two-step exposure, using both a dark and clear (light) field mask set, in addition to a hard-bake resist step. In contrast to Dai, the Applicant's invention incorporates two positive photoresist systems, which have different wavelength sensitivities, to form trench and via openings with only a two-step etching process. In addition, the two layers of photoresist exhibit different etch resistant properties, for subsequent selective reactive ion etching steps.

Reconsideration of the rejection of claims 1-7, 9-17, 19-27, 29, 30 under 35 U.S.C. 103(a), as being unpatentable over Jang (US 6,110,648, hereafter referred to as Jang), in view of Tobben et al. (US 6,103,456, hereafter referred to as Tobben), and further in view of Orvek et al. (US 4,770,739, hereafter referred to as Orvek), is requested, based on the following.

There are significant patentable differences between the Applicant's invention and the prior art references of Jang, in view of Tobben, and further in view of Orvek

The main focus of the Jang invention is as the title states, "METHOD OF ENCLOSING COPPER CONDUCTOR IN A DUAL

DAMASCENE PROCESS." Jang teaches a method of enclosing copper conductors in a protective material. Hence, Jang claims that the problems of corrosion and de-lamination through diffusion of copper are eliminated. The Applicant's inventions is directed toward simplifying a dual damascene process by saving processing steps, reducing etch steps, by the specific use of two different photoresists. The two different photoresists are used in the formation of self-aligned dual damascene interconnects and vias. Note, that the Applicant's invention incorporates two positive photoresist systems, which have different wavelength sensitivities, to form trench and via openings with only a two-step etching process, instead of the conventional three etching steps.

The Applicants agree with the Examiner that Jang does not teach the use of:

A) a top insulating dielectric layer over a three-layer stack (ref. Applicant's claims 1,5,11,15,21,25)

B) the use of a near-UV (365nm) photoresist and a deep UV (268nm) photoresist, applied as a two layer resist system and differs from Orvek, since the Applicant claims a scheme for a two pattern transfer system.

(ref. Applicant's claims 1,6,7,11,16,17,21,26,27)

C) Furthermore, Jang does not teach the following key points, found in the Applicant's invention: the formation of

self-aligned dual damascene interconnects and vias, which incorporate two positive photoresist systems, which have different wavelength sensitivities, to form trench and via openings with only a two-step etching process. In addition, the two layers of photoresist exhibit different etch resistant properties, for subsequent selective reactive ion etching steps.

In addition, there are significant patentable differences between the Applicant's invention and the prior art references of Jang, in view of Tobben.

Tobben's invention is focused on the prevention of photoresist poisoning caused by reactive gases from a silicon oxynitride layer, which is used as a dielectric anti-reflective coating (DARC) for a subsequent overlying photoresist layer. There are significant patentable differences between the Tobben disclosure and the Applicant's dual damascene process using two resist layers. Agree with the Examiner that Tobben teaches the prior-art of a dual damascene process, with the use of a top silicon oxynitride layer. This element is common to many processes in use, including that of the Applicant's.

In addition, there are significant patentable differences amongst the Applicant's claimed invention and the prior art references of Jang, in view of Tobben, and further in view of Orvek.

The Orvek disclosure is concerned with planarizing an irregular surface with a first layer of planarizing photoresist, the bottom layer. The second layer of photoresist is coated over the first, and forms a top layer. Agree with the Examiner that the two resist have different sensitivities to UV light, and the top resist is exposed and patterned. The top resist pattern is then transferred exactly to the bottom resist pattern. As the Examiner states, the Orvek process teaches that the Orvek process scheme increases resolution. However, the Orvek scheme produces added processing steps and is costly, in that two photoresists are used to define only one pattern. There are major differences between the Orvek process and that of the Applicant's process. The Orvek process uses two different photoresists to define only one pattern, whereas the Applicant's process uses two different photoresists to define two patterns, in dual damascene the trench and via. Politely disagree with the Examiner that it would have been obvious to use a deep UV resist over a near-UV resist in Jang and Tobben's dual

damascene process, just because Orvek teaches an increase in resolution. The key point is that Orvek teaches an increase in resolution for defining or transferring only one image size pattern.

The combination of Jang, Tobben and Orvek would still not produce the Applicant's invention, as claimed in the Claims.

Due to the above arguments, the claims are believed to be patentable over Jang, Tobben and Orvek.

In conclusion, for state-of-the-art advanced applications in silicon technology, the Applicant's invention is believed to be patentable over Jang, Tobben, and Orvek, because there is insufficient basis for concluding that the modification of Prior Art disclosures would have been obvious to one skilled in the art. That is to say, there must be something in the prior art or line of reasoning to suggest that the combination of these various references is desirable. We believe that there is no such basis for the combination of Jang, Tobben, and Orvek.

Reconsideration of the rejection of claims 8,18,28 under 35 U.S.C. 103(a), as being unpatentable over Jang (US 6,110,648, hereafter referred to as Jang), in view of Tobben et al. (US 6,103,456, hereafter referred to as Tobben), and further in view of Orvek et al. (US 4,770,739, hereafter referred to as Orvek), as applied to claims 1-7, 9-17, 19-27, 29,30 above, and further in view of Pu et al. (US 5,843,847, hereafter referred to as Pu), is requested, based on the following.

There are significant differences amongst the Applicant's invention and the prior art references of Jang, in view of Tobben, and further in view of Orvek, and further in view of Pu.

The Pu invention, as the title indicates, it is concerned with selective etching processes. It does not address the Applicant's invention and Pu's figures indicate only one photoresist layer, reference Pu figures: Fig. 1A, Fig. 1B, Fig. 1C, and Fig. 1D, in each the photoresist layer is labeled #40. Agree with the Examiner that some of the process chemistry for reactive ion etching of silicon nitride and silicon oxynitride, as taught by Pu and the Applicants are similar, as the chemistries would be for etching nitride layers. Politely disagree with the Examiner that, it would



have been obvious to one of ordinary skill in the art at the time of the invention was made to:

(A) use Pu's process to etch the layers on (B) Jang and (C) Tobben's stack with (D) Orvek's resists, because (E) Pu teaches that this leads to better etch.

In addition, the Applicant's two layers of photoresist were especially formulated to exhibit different etch resistant properties, for subsequent selective reactive ion etching steps, for via and trench formation.

The combination of Jang, Tobben, Orvek and Pu, would still not produce the photoresist stacks found in the Applicant's invention, Fig. 2A and Fig. 2B.

Due to the above arguments, the claims are believed to be patentable over Jang, Tobben, Orvek and Pu.

In conclusion, for state-of-the-art advanced applications in silicon technology, the Applicant's invention is believed to be patentable over Jang, Tobben, Orvek and Pu, because there is insufficient basis for concluding that the modification of Prior Art disclosures would have been obvious to one skilled in the art. That is to say, there must be something in the prior art or line of reasoning to suggest

that the combination of these various references is desirable. We believe that there is no such basis for the combination of Jang, Tobben, Orvek and Pu.

CLOSING REMARKS

The Examiner Kripa Sagar is again thanked for carefully examining and reviewing the subject patent application. The specifications and claims have been reviewed in accordance with all the Examiner's kind suggestions, and after amending the specifications and all the claims 1-30 in accordance with the Examiner's helpful suggestions, all claims are now believed to be in condition for allowance.

All rejected claims are now believed to be in allowable condition, and allowance is so requested.

It is requested that should there be any problems with this Amendment, please call the undersigned Attorney at (845) 452-5863.

Respectfully submitted,



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